SOLUTIONS

SOLUTION ▸ *DRIVEN* SCIENCE™ SPRING/SUMMER 2007 VOLUME 1 ▸ ISSUE 1

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College of Food, Agricultural and Natural Resource Sciences
University of Minnesota

Solutions magazine is published three times a year for friends, alumni, faculty, staff and students at the College of Food, Agricultural and Natural Resource Sciences. Like the college, the magazine focuses on how science leads to solutions for today's problems in food and agricultural systems; global climate and environmental change; and bioenergy and bioproducts.

CFANS is comprised of six divisions, 14 academic units (two are held jointly), seven research and outreach centers throughout Minnesota, the Bell Museum of Natural History and the Minnesota Landscape Arboretum. The college also participates in many interdisciplinary centers and cooperatives.

Tell us what you think.
Solutions welcomes readers' comments and story ideas for future issues.

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Inside SOLUTIONS

SOLUTION ▸ *DRIVEN* SCIENCE™

Welcome to our first issue of *Solutions*.

These are particularly exciting times for the College of Food, Agricultural and Natural Resource Sciences. Faculty, students and staff investigate and teach about a host of local and global concerns relevant to agriculture and natural resources.

- Biofuels may aid in solving our needs but might also result in rising prices for foods and affect the environment. We can help find ways to use non-food plants, such as prairie grasses, that could alleviate the increased cost of crops used for both food and fuel without harming the environment.
- We can affect human health by altering the components in food that are "chemoprotective," leading to prevention of cancer and other degenerative diseases.
- We can improve our lifestyles by designing pleasing recreational spaces.
- We can help protect threatened plant and animal species.

Solutions will provide updates about the efforts of our CFANS community. We have a diverse group of stakeholders representing students, alumni, small and large businesses, rural and urban populations, and the entire population of the University of Minnesota. We recognize our responsibility to the Land Grant mission and the trust that our stakeholders place in our efforts to conduct contemporary scientific inquiry into relevant problems and to share our knowledge with students and the public.

CFANS emphasizes Solution-Driven Science. We expect *Solutions* to inform and to entertain, leading to continued discussions and partnerships about Food, Agricultural and Natural Resource Sciences in Minnesota and beyond.

Allen Levine
Dean

A little bitter, a lot better

Enhanced veggies may save lives

By Becky Beyers

"Eat your vegetables" has long been good advice for those who want to stay healthy. Now, imagine having access to super-vegetables with extra cancer-fighting properties — and they taste good.

That's the vision of scientists at the Southern Research and Outreach Center (SROC) in Waseca, where ongoing experiments are aimed at developing a way to consistently mass-produce vegetables with high levels of cancer-preventing compounds found in cruciferous vegetables like cabbage, broccoli, Brussels sprouts and turnips.

Cruciferous vegetables naturally produce compounds called glucosinolates as a way to fend off disease and insect attack, says Vince Fritz, a professor in the Department of Horticultural Science who's located at the SROC. Because plants produce these compounds as a response to stress, scientists at the SROC are experimenting with different environmental stressors — water,

light, fertility or temperature, for example — to trigger the plants to create more of the healthy phytochemicals. Experiments so far have concluded:

• More crowded plants in the field produced the compounds more uniformly from plant to plant.

• Red cabbage varieties have greater concentrations of the healthy compounds than green varieties.

• Cabbage placed in optimum storage conditions for as long as four months shows no sign of compound degradation.

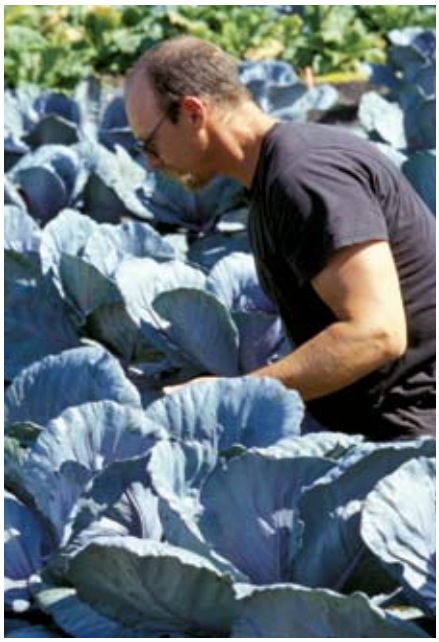
This growing season's experiments at the SROC will include, among other things, determining whether using different colored plastic mulches in the field can affect production of targeted compounds in turnips.

The plant's ability to produce these cancer-preventing agents is measured through a process of harvesting the vegetables, then boiling, pureeing and freezing samples, before analyzing them via chromatography. Most experiments have involved cabbage, although watercress, turnips, Chinese cabbage and Brussels sprouts also have been studied.

The researchers' task has an additional complication: the bitter taste in many of these vegetables comes from the very same chemicals that make them cancer-fighters. So scientists must balance their goal of boosting the glucosinolates in, say, Brussels sprouts without making them so bitter that consumers won't eat them.

That problem can be addressed. For example, harvesting cabbage later in the fall means it has more sugar and tastes less bitter, Fritz says. "There may be methods to increase the concentration of one, or a few targeted compounds and keep the others constant such that increasing bitterness is prevented," he says.

The current research continues work that started with the Center for Plants and Human Health, an interdisciplinary research effort started in the early part of this decade that included scientists from a range of disciplines. Fritz and others working on growing the enhanced vegetables now are collaborating with scientists from the university's Cancer Center, the Mayo Clinic and the Hormel Institute, as well as colleagues in other departments and colleges.



Cabbage grown at the Waseca research and outreach center is tested for response to various kinds of environmental stressors.

"It's established beyond a shadow of a doubt" that cruciferous vegetables have cancer-preventing agents, says Steve Hecht, program leader for the Carcinogenesis and Chemoprevention Research Program at the Cancer Center. He began collaborating with CFANS scientists through the Center for Plants and Human Health. Developing vegetables with extra cancer-fighting properties is extremely important to the Cancer Center's efforts, he says, "because we can't do the sorts of things that people in CFANS who know about plants can do."

The University of Minnesota is uniquely positioned for these kinds of collaborations, Fritz and Hecht say, because few other major universities have both a strong medical school and a strong agricultural college.

Vince Fritz and his colleagues test the cancer-fighting properties of vegetables through a process of freezing, pureeing and analyzing.

Practical research like growing enhanced vegetables has the potential to attract regional and federal funding because of the public's interest in cancer prevention, Fritz says. "We hope there's an opportunity for funding because of the translational research we do. The ability to take the basic scientific knowledge and test it on a larger scale, has the potential to make a real impact."

Still, many consumers, even though they understand the benefits of eating healthy food, simply don't eat enough cruciferous vegetables. The U.S. Department of Agriculture estimated last year that fewer than half of Americans eat the recommended amount of fruits and vegetables each day.

Different vegetables provide a variety of compounds that might prevent cancer.

Some of the problem may be cultural, says Sabrina Peterson, an assistant professor in the Department of Food Science and Nutrition who has studied how vegetables in the carrot family help prevent cancer. In other cultures, social norms dictate that people eat lots of vegetables, regardless of their bitter taste. That isn't the case here. Researchers from a broad range of disciplines may have to work together to figure out how to counteract Americans' bad eating habits, she says.

For the food industry, the success of a super-vegetable will depend on consumers' response, says Jean Kinsey, co-director of the Food Industry Center and a professor in the Department of Applied Economics. "If these vegetables taste good and they're in the form we expect, people will buy them. And if consumers want them, the industry will respond." She expects that when super-vegetables become available at the supermarket, they'll be a niche product, along the lines of organics. "It's kind of the same thing in that consumers who are interested will be really interested," and willing to pay a premium price for enhanced vegetables, she says.

Fritz also expects that someday super-vegetables will be on the market alongside "traditional" vegetables and that enhancements could be made to a variety of vegetables, not just one. Chinese cabbage, for example, has different primary glucosinolates than traditional cabbage.

How will the researchers know when they've made a big breakthrough? "The development of a production system that produces vegetables with enhanced health benefits on a consistent basis would be one of our first big steps," Fritz says.

"We're just beginning the journey in this new frontier." ■

▶ 24-carrot promise:

Sabrina Peterson's work explores how carrots may prevent cancer

Sabrina Peterson wants to know: Exactly how do certain vegetables help prevent cancer?

The assistant professor in the Department of Food Science and Nutrition studies how enzymes in the human body — specifically, an enzyme in the liver called CYP1A2 that activates potential cancer-causing agents — show decreased activity when humans eat more vegetables from the carrot family.

> "There are hundreds of compounds. I'm very curious about what they do."

While most people think of foods as being comprised of fat, protein, vitamins and minerals, "there's a whole lot more in there," says Peterson, who was drawn to studying the compounds in food when she returned to graduate school after five years as a dietician. "There are hundreds of compounds. I'm very curious about what they do."

Since arriving at the University of Minnesota just over a year ago, Peterson has been exploring the possible next steps in her research. In earlier studies at the University of Washington, she tested the effects of certain phytochemicals found in apiaceous vegetables — the carrot family — to see how those compounds might inhibit the development of cancer. The experiments showed positive results; the vegetables have something in them that slows down the effects of CYP1A2 on cancer-causing agents.

Her work in CFANS and with the University's Cancer Center could take several paths:

> "We have to study diet patterns versus singular foods," she says. "People don't just eat one food or foods from just one family. We're exposed to a variety of things at every meal."

Do other compounds found in the carrot family also inhibit the enzyme? What about citrus, which has some similar compounds and might also slow down the activation by enzymes? Or is there a way to get an amplifying effect from multiple cancer-preventing compounds?

Peterson, who is 36 and a native of California, expects to spend the rest of her career looking for answers to those questions. She's also interested in nutrigenomics research — studying whether genetic differences will cause the enzymes to respond differently to the phytochemicals and their food sources. For her, the big breakthrough would be understanding how the compounds inside food work together to create combined effects. "We have to study diet patterns versus singular foods," she says. "People don't just eat one food or foods from just one family. We're exposed to a variety of things at every meal." *–Becky Beyers*

Sabrina Peterson

Digging up the dirt on viruses:
Ben Lockhart's diagnoses keep gardeners' plants healthy

Ben Lockhart

When the garden plant you buy at the neighborhood greenhouse is healthy, thank Ben Lockhart.

Lockhart, 62, a native of the West Indies who's been with the Department of Plant Pathology since 1971, is known worldwide for his research on plant diseases. Last fall, he was named a fellow of the American Phytopathological Society.

Lockhart believes that while basic science research is important, part of the University of Minnesota's role, especially in CFANS, is being accessible to citizens and providing practical solutions to problems faced by consumers and businesses.

While much of his earlier career focused on vegetable and food crops — he spent 10 years in Morocco working on viruses affecting local agriculture — his recent research has dealt with viruses that can affect ornamental plants. He says his interests changed because of the growing size of the ornamental-plant industry; because so many new plants are being introduced; and because the ornamental-plant industry has gone global. Plants being imported and exported around the world can bring with them a variety of diseases and pests.

> "To me, it's like a big jigsaw puzzle and your job as a scientist is to put in one piece. You do it well enough so that people can depend on it."

His research uses electron microscopy to search for all possible viruses, not just those that have been previously identified. Last year, for example, he found five new viruses that can affect roses. None of the viruses are life-threatening — Lockhart says most wouldn't even be visible to the average gardener — but they were the first new rose viruses identified in decades. Most other pathologists were looking only for the known viruses, not for new ones. He'll talk about rose viruses this summer at the American Rose Society's national convention, which is in St. Paul.

"The process of exploration is what's exciting," he says. "Too many people look for instant gratification in science."

Technology has made a big difference in his work. "It's so exciting, I can't wait to come to work every day," he says. Where identifying a virus in the pre-database era could be a laborious process taking months, now a new virus can be identified in a matter of a few days. The rapid spread of news on the Internet means Lockhart now gets e-mails from gardeners around the world who have read about one of his discoveries and need help with their sickly plants. He's happy to offer advice, often going out to local gardens to get a firsthand look.

"The process of exploration is what's exciting," he says. "Too many people look for instant gratification in science. To me, it's like a big jigsaw puzzle and your job as a scientist is to put in one piece. You do it well enough so that people can depend on it." *–Becky Beyers*

Seeing the forest for more than the trees:
Mike Kilgore wants Minnesota to maintain its resources

Whether it's to fish, hunt or simply go for a walk in the woods, Mike Kilgore, associate professor of natural resources policy and economics in the Department of Forest Resources, is always looking for a reason to escape the indoors. "My kids are all outdoorsmen too," says Kilgore. Anyone could see this when stepping into his office in Green Hall, where there's a photo of his three sons posing in hunter's orange alongside the family's Brittney spaniel, Buddy.

> "Awhile back, my dad gave me some of his father's old hunting licenses and duck stamps. They're just great."

The outdoor experiences that Kilgore shares with his sons are the very same ones that his father and grandfather shared with him when growing up in rural Minnesota. But one element continues to change. The woods that Kilgore walks today aren't the same woods his grandfather walked and they won't be the same 40 years from now. It's a reality that motivates Kilgore's service, teaching and research.

"Awhile back, my dad gave me some of his father's old hunting licenses and duck stamps. They're just great," Kilgore says with a smile. "When I was looking at them the other day, it made me wonder what my grandfather would think of Minnesota's landscape today. I think he'd say we've really altered it. We've put a lot of pressure on the resources."

This pressure isn't going unnoticed in Minnesota. This past fall, Gov. Tim Pawlenty formed the Conservation Legacy Council — a 15-member council charged with finding a model to effectively fund, govern and deliver natural-resource conservation in the state. Kilgore, with his love of the outdoors and extensive knowledge of natural resources economics and policy in Minnesota, was asked to chair the council. He welcomes the opportunity.

"Conservation policy and funding have been growing and becoming more visible in Minnesota," says Kilgore. "This is the time to make a difference." The council is expected to deliver its report in late spring.

> "I like to see how students come to appreciate, over the course of the semester, that natural-resource management is not just a biological or physical problem," says Kilgore. "It also has an important social component that centers around how individuals and society value these resources."

While the council demands quite a bit of time, Kilgore still manages to stay on top of his teaching and research responsibilities. Since 2001, when he joined the Forest Resources faculty, he's taught the department's Economics of Natural Resource Management course.

Mike Kilgore

"I like to see how students come to appreciate, over the course of the semester, that natural-resource management is not just a biological or physical problem," says Kilgore. "It also has an important social component that centers around how individuals and society value these resources." *–Sarah Finley*

By Kermit Pattison

Marvin Bauer approaches the problem of urban water runoff with some perspective. He starts 438 miles above the earth.

Why concerns about it could flood Minnesota's waters

Bauer, a professor in the Department of Forest Resources, sits at his desk as his computer displays a satellite image of the Twin Cities, with dark splotches showing concentrations of impermeable surfaces like rooftops and pavement. These surfaces repel rain — and there lies the root of a serious environmental problem.

"More impervious surface means more runoff," says Bauer. "When it rains, that water has to go somewhere. Pretty much all of the effects are going to be on the negative side." The massive runoff brings a cascade of unintended consequences: water pollution, depletion of groundwater, flooding and harm to wildlife. According to the U.S. Environmental Protection Agency, urban runoff is the third-leading cause

Techniques developed in CFANS labs will help slow the flow of stormwater runoff from impermeable surfaces like highways.

of freshwater pollution. This problem has profound implications for Minnesota, a land of 14,000 lakes, 92,000 miles of streams and rivers and one trillion gallons of groundwater.

Several professors from the College of Food, Agricultural and Natural Resource Sciences are grappling with the problem and helping devise solutions. Bruce C. Wilson, a storm water research scientist at the Minnesota Pollution Control Agency, says, "The University of Minnesota is one of the prime storm water research universities in the country."

Urban development has substantially changed the natural flow of water. Originally, the land was covered in prairie, forests, savannahs and wetlands, and water slowly percolated through this giant filtration system.

In the 19th century, farmers installed drainage ditches and tiles to make fields suitable for planting. Then urban development covered the land with buildings, roads, sidewalks, parking lots and storm water systems — all designed to remove water as quickly as possible and channel it toward lakes and rivers.

More recently, researchers and regulatory agencies have become more sensitive to the consequences of these practices. "Over the past 10 or 15 years, there's been agreement that the amount of impervious surface area is a good indicator of a lot of things related to environmental quality," says Bauer.

Bauer's work has helped the state appreciate the scope of the problem. In the past, researchers relied on aerial photographs to create maps of impervious surfaces. He and his colleagues at the Remote Sensing and Geospatial Analysis Laboratory have emphasized analysis of satellite images. (see www.land.umn.edu).

Minnesota is one of the first states with such comprehensive maps of impervious surfaces. This data has helped the Minnesota Pollution Control Agency and other government agencies understand urban runoff and its effect on lakes and streams.

In the Twin Cities, impervious surfaces increased 44 percent in less than two decades.

"Once the impervious surface goes above 10 percent, you start seeing real negative impacts in the streams and receiving waters," says Jim Anderson, co-director of the Water Resources Center and a professor in the Department of Soil, Water and Climate.

In some areas, the concentrations are considerably higher. In St. Paul, impervious surfaces cover 45 percent of the land. Bauer's computer images provide graphic illustrations: concentrations of gray and black interspersed with a few patches of green.

Meanwhile, outlying areas are becoming less green. In fast-growing suburbs like Anoka and Carver Counties, impervious surfaces more than doubled between 1986 and 2002.

These changes are just as dramatic on the ground. Water rushes off these surfaces, picking up toxic chemicals, sediments, nutrients and organic materials — all of which wind up in streams, rivers and lakes.

Phosphorus and nitrogen from fertilizers run into lakes, causing excessive growth of algae and weeds and turning once clear waters into murky pools depleted of oxygen. Automotive wastes, sand and salt wash from roadways and parking lots, and pollute freshwater habitats.

Runoff flows from these hard landscapes with the intensity of a flash flood. These impermeable surfaces increase the volume and velocity of water flow, causing erosion of stream beds and carrying sediments downstream.

Marvin Bauer

Urban runoff can even cause a temperature spike in sensitive habitats such as trout streams. Water warms as it flows over these urban surfaces and has a shock effect when it pours into freshwater habitats.

The impermeable landscapes also inhibit the natural infiltration of water into the soil and the recharging of groundwater supplies. Meanwhile, this same groundwater is being tapped for drinking water, industry and irrigation.

(***RUNOFF*** *continued on page 13)*

Hayes winner seeks end to wheat diseases

For Xiuling Zhang, it's all about the quest for knowledge. This year's winner of the H.K. Hayes award earned her undergraduate and first master's degree in her home country, China. In the 1990s, she studied with the International Maize and Wheat Improvement Center (CIMMYT) and eventually found herself at South Dakota State University.

"It was a great opportunity to work at a small university," she says now. "I learned a lot and learned how you can do a lot with a small amount of resources." Her work at SDSU also taught her the importance of listening to what growers want, she says.

But as she became more involved in research projects there, she realized she wanted to lead research on her own, and that she needed to earn a Ph.D. She chose the Department of Agronomy and Plant Genetics at CFANS primarily because of her now-adviser, Jim Anderson, and his work on developing strains of disease-resistant wheat.

Now, as she nears the end of her Ph.D. program, she's happy she took the leap and returned to graduate school. She's collaborated with researchers from CIMMYT and at the Cereal Disease Lab on campus and currently is working on breeding new varieties of wheat with longer-lasting rust resistance. Most new varieties include some genetic resistance, she says, but typically after 3 or 4 years the resistance wears out. By mapping specific genes in rust-resistant wheat varieties, Zhang and her colleagues hope to find a solution to a global problem.

After she finishes her doctorate, Zhang, hopes to continue her research work and to teach at a university.

The Hayes award is given to an outstanding graduate student in agronomy and plant genetics and is named for Professor H.K. Hayes, a world-renowned researcher, teacher and author who developed techniques for breeding hybrids and disease resistance.

Xiuling Zhang

Norman Borlaug to be awarded Congressional Gold Medal

Norman Borlaug, winner of the Nobel Peace Prize and a CFANS alumnus, will receive the Congressional Gold Medal, the nation's highest civilian honor awarded by Congress. A date for the award has not yet been announced. President Bush signed the legislation authorizing the award on Dec. 16.

Borlaug, 93, earned his bachelor's, master's and Ph.D. degrees from the University of Minnesota. He's known as "the father of the green revolution," which brought modern farming techniques to developing countries in the 1960s and 1970s. In 1970, he was awarded the Nobel Peace Prize for his work.

Morse Award goes to Jay Bell

Professor Jay Bell of the Department of Soil, Water and Climate has won the Horace T. Morse-University of Minnesota Alumni Association Award for Outstanding Contributions to Undergraduate Education. He is one of only seven faculty members to earn the prestigious teaching award for 2006-07.

Bell teaches three advanced courses in soils plus two freshman seminars. He is co-coordinator of the Environmental Science, Policy and Management major and is a co-editor of Geoderma, the global journal of soil science.

He calls himself a "professor of pedology with emphasis on geospatial research, digital soil mapping, scientific visualization, wetland soil, geomorphology and soil genesis." He earned his bachelor's and master's degrees in agronomy from Virginia Polytechnic Institute and State University, and his Ph.D. in agronomy from Penn State University. He's been at the University of Minnesota since 1991 and has won several other teaching awards.

Swackhamer serves on environmental council

Professor of environmental health sciences Deborah Swackhamer, who also directs the U's new Institute on the Environment, is one of 15 citizens appointed by Gov. Tim Pawlenty to the Clean Water Council. The council was created by the Legislature in 2006 to advise on administering and implementing the Clean Water Legacy Act. It consists of 23 members, with 19 appointed by the governor.

'Speaking of Science' interview series highlights CFANS researchers

"Speaking of Science" is a series of interviews between CFANS dean Allen Levine and key faculty and staff that has been appearing on college websites. Interviewees so far have included:

Mike Sadowsky, Distinguished McKnight University Professor in the Department of Soil, Water and Climate

Phil Pardey, Professor of Applied Economics and director of the International Science and Technology Practice and Policy (InSTePP) Center

Jim Anderson, co-director of the Water Resources Center and a professor in the Department of Soil, Water and Climate

Mindy Kurzer, Professor and Director of Graduate Studies — Nutrition in the Department of Food Science and Nutrition

An edited transcript of each interview is posted on the website — www.cfans.umn.edu — along with audio transcripts of the entire session.

Plant Pathology plans centennial celebration

The Department of Plant Pathology will mark its 100th birthday this fall with a formal celebration that includes a picnic/softball game, tours, awards and social gatherings. The celebration runs from Sept. 18–21 on the St. Paul campus and is expected to attract alumni and friends of the department from around the world.

In 1907, the department was formed as the Division of Vegetable Pathology; since then its focus has expanded to a broad range of research and teaching specialties.

Gerald Fischer, UM Foundation; Allen and Nancy Levine; Cynthia Cashman, CFANS chief development officer.

Levine scholarship will aid new students

A new scholarship funded by a donation from CFANS Dean Allen Levine and his wife, Nancy Levine, will help fund the studies of students who are interested in health and agriculture or health and natural resources.

The Allen S. and Nancy Levine Scholarship will be awarded to entering freshmen or transfer CFANS undergraduate students based on financial need and academic interests. The amount to be awarded will be determined each year. The awards will be matched by the University of Minnesota Foundation: essentially doubling the value of he gift.

The scholarship was announced in April at the annual Classes Without Quizzes event. One factor in creating the scholarship, Allen Levine says, is that he believes that as a leader of the college, he should set an example for philanthropy.

CFANS faculty named to advisory committee

Nevin Young

Ronald Phillips

Provost Thomas Sullivan has named a University-wide advisory committee for a proposed interdisciplinary Institute for the Advancement of Science and Technology. The committee will develop ideas on what the institute must do to enhance academic synergies; promote development of large interdisciplinary grants; bring productive teams of interdisciplinary researchers together across the university; substantially increase communication and collaboration across science, medical and engineering research; and to "add value" to the university's research portfolio. Professors Nevin Young of the Departments of Plant Biology and Plant Pathology and Ronald Phillips of the Department of Agronomy and Plant Genetics have been named to the advisory committee.

The committee will report back to the provost this spring.

Gates Foundation grant aimed at ending hunger and poverty

Professor Phil Pardey of the Department of Applied Economics is co-principal investigator on a recently announced three-year, $3.7 million grant from the Bill and Melinda Gates Foundation. As part of the Harvest Choice initiative, Pardey — who also directs the International Science and Technology Practice and Policy center — and his colleagues at the International Food Policy Research Institute will help the Foundation choose how to invest strategically in agricultural development.

Pardey also recently was one of just two people to be named a Distinguished Fellow of the Australian Agricultural and Resource Economics Society (AARES) in Queenstown, New Zealand.

Fellows will help lead Institute on the Environment

Four CFANS faculty members are "Founding Fellows" of the University's new Institute on the Environment. The 15 Founding Fellows will lead the establishment of the institute. Their appointments last for up to two years. CFANS faculty in the group include Susan Galatowitsch, professor in the horticultural science department; Anne R. Kapuscinski, professor in the Department of Fisheries, Wildlife and Conservation Biology; David Mulla, professor in the soils, water and climate department; and Stephen Polasky, professor in the Department of Applied Economics.

Susan Galatowitsch

Anne R. Kapuscinski

David Mulla

Stephen Polasky

98 percent Placement rate of CFANS graduates, according to a recent study by the St. Paul Campus Career Center

#1 Ranking of the University of Minnesota in scholarly publications on agricultural topics; CFANS faculty contribute more than half of those publications.

86 percent of first-year CFANS students return for a second academic year

27 percent of CFANS graduates have had an international study experience

13 graduate programs OFFERED THROUGH **CFANS**

10 PERCENT increase in CFANS enrollment over the past 5 years

5 of the University's 15 interdisciplinary graduate programs are offered by CFANS

51.2 PERCENT Increase in the number of graduate or professional degrees awarded by CFANS from 2002 to 2006

35 Number of CFANS faculty with research grants funded by the Initiative for Renewable Energy and the Environment

Source: College of Food, Agricultural and Natural Resource Sciences 2007–2008 compact

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(***RUNOFF*** *continued from page 9)*

"We're using more water than what is being replaced by the natural system," says John Nieber, a professor in the Department of Bioproducts and Biosystems Engineering. "It's like a bank account — if we take more than what is being put into the account, the amount stored eventually decreases to the point where it is in the red."

Nieber says that better practices for sustainable use of water are needed in urban, suburban and rural areas, and this will require new tools for assessing freshwater sustainability. One of his research projects will develop "water sustainability atlases" for Minnesota. He's overseeing a two-year project that will compile a hierarchy of flow fields in surface water, vadose zone (the portion of the earth between the land surface and zone of saturation) and groundwater, and analyze rates of runoff, groundwater discharge and recharge.

The project will produce maps at a 1:3 million scale and more detailed maps for specific regions of the state. After proving the effectiveness of the method, Nieber hopes to complete similar maps for other parts of the state.

Meanwhile, cities and developers are turning to more environmentally friendly strategies that allow water to naturally soak into the ground and reduce pollution. They include rain gardens, settling ponds, infiltration trenches and even porous pavements. In coming years, cities and developers will face more stringent regulations to comply with the federal Clean Water Act.

"The good news is we're already doing a lot of that stuff in Minnesota," says Anderson. "But they don't know if they're controlling it to the level they need to or not."

How effective are these techniques? The University of Minnesota is helping answer that question by developing a manual to help assess these practices under a contract with the Minnesota Pollution Control Agency. Anderson and John Gulliver, a professor in the Department of Civil Engineering, are the principal investigators leading the effort, and Nieber also serves on the project team.

"Minnesota is definitely a leader in the country," says Anderson. "We're doing things that other people have only been talking about doing. In terms of overall approach, Minnesota is right out there at the front of the pack." ■

Students learn firsthand how runoff can affect water quality.

Prairie project may reshape the renewable fuel landscape

By Todd Nelson

Few places grow more corn, use more fertilizer or are more windswept than Minnesota.

Under a unique plan led by CFANS scientists that could boost both renewable energy and rural development, the state would become the first place in the world to harness some of its wind energy to make fertilizer to help raise future crops.

That's the aim of a pilot project taking shape at the West Central Research and Outreach Center in Morris, Minn. The first piece — a towering wind turbine that supplies half the electricity used at the nearby University of Minnesota-Morris campus — has been in place since March 2005.

An accompanying facility, now in design, will convert a portion of the turbine's wind power into hydrogen.

In a subsequent stage, a chemical reaction between the hydrogen and nitrogen drawn from the surrounding air would produce anhydrous ammonia fertilizer, which would in turn be applied to crops in order to raise yields and provide more corn for the state's feedlots and ethanol plants, which turn grain and cornstalks into fuel. Construction is to begin this fall, with the system to go online next summer.

"It will be the only wind-to-hydrogen-to-ammonia system in the world," says Michael Reese, renewable-energy director at WCROC, who's credited with envisioning the new use for what happens to be decades-old technology.

In offering a renewable alternative, the WCROC system could help replace some of the $300 million in imported anhydrous ammonia that Minnesota farmers use each year, Reese says. Much of that ammonia comes from other countries and is derived from natural gas, a fossil fuel that emits greenhouse gases and likely will continue to rise in price as wind energy costs decrease.

The irony, Reese says, is that imports of fossil-fuel-based fertilizer have increased as Minnesota has ramped up production of ethanol, a locally produced biofuel, in an effort to move away from using imported fossil fuels.

The new system could propel Minnesota, a leader in producing wind energy and ethanol, to the forefront of the hydrogen economy, Reese says. A growing commercial market for hydrogen could spur development in much the same way as the state's ethanol production has drawn manufacturing and technology companies and jobs to the state.

"We really view this as a model similar to the ethanol plants, where locally owned systems provide economic development and job opportunities for rural Minnesota and rural portions of the Midwest," Reese says. With this approach, the hydrogen-derived fertilizer becomes a value-added product for use in rural areas where it is produced, which will help make greater use of the state's vast wind energy potential, Reese says.

That also eliminates the challenge of moving wind energy through a highly constrained transmission system to get it to distant markets such as the Twin Cities.

While hydrogen can be difficult to store, most rural communities already have

facilities for storing, moving and using anhydrous ammonia, which is in high demand for agricultural use throughout the Midwest, Reese says.

The project is funded by the state of Minnesota, Xcel Energy and Norsk Hydro, a Norwegian company that makes electrolyzers, which produce synthetic hydrogen.

The pilot system will use a 400-kilowatt electrolyzer to produce 365 tons of ammonia a year, Reese says. Some of that will be used on the research and outreach center's farm fields and plots and the rest marketed to local co-ops and farmers.

The technology for producing ammonia from the reaction of hydrogen and nitrogen has been around since the 1930s, says Greg Cuomo, director of the University of Minnesota Outreach, Research and Education Park in Rosemount. In some cases it has seen large-scale industrial use.

Michael Reese leads the project at Morris.

"Our question is, can we do it at a local level, with one, five or 10 wind turbines, economically?" says Cuomo, who is the former director of the West Central ROC.

The project is an example of what the outreach and research center in Morris is doing to improve life in rural west-central Minnesota, Cuomo says.

"A unique role of the research and outreach center is to do innovative research that can move technologies into practical use," Cuomo says. "We tried to think about this as a rural economic development problem as well as a research problem, to connect the work we do to the citizens in the region and to bring university research to solve problems facing agriculture in the state."

The fertilizer produced from a wind turbine would have a lower carbon imprint than fertilizer produced from natural gas, says Doug Tiffany, research fellow in the Department of Applied Economics. As a result, corn grown with the wind-produced anhydrous ammonia would also contain less carbon, as would ethanol produced from the corn.

Wind power already provides half the electricity needed to power the University of Minnesota-Morris campus.

Such ethanol would be very attractive in California, where state policy calls for lowering the carbon imprint of fuels, Tiffany says. That would make the fertilizer more valuable to farmers growing corn for ethanol production.

Using wind energy to produce anhydrous ammonia would allow construction of wind turbines in areas not well-served by transmission lines, which has been an obstacle to developing wind energy, Tiffany says. "We can put up wind turbines faster than we can get the transmission capacity built," Tiffany says. "This way we step right past that and say we're going to serve another market. The question is, can we make money at it?"

If the wind-to-hydrogen-to-ammonia pilot project works both on scientific and economic grounds, it would trigger a welcome investment in wind-energy technology, says Cecil Massie, a renewable-energy expert with the Sebasta Blomberg engineering firm in St. Paul, who will design the WCROC system.

Estimates are that Minnesota would need 2,000 megawatts of turbines in place to make enough hydrogen to meet the state's nitrogen fertilizer demand, Massie says. Maintaining those turbines alone would create an estimated 400 jobs. "Talk about an engine for rural

Some of the ammonia produced will be used on the research center's fields, and the rest marketed to local farmers.

economic development," Massie says. "This is huge stuff."

As with ethanol, local producers likely would join to develop hydrogen production facilities. "In an ideal circumstance, the corn farmer owns the windmill," Massie says. "The guy who's going to make the main use of the product is the guy who's going to control the manufacture of it. You start vertically integrating farming operations from the fertilizers all the way to the final energy conversions."

Building enough turbines to meet the state's demand for hydrogen-produced fertilizer could take six to 10 years, Massie says.

If the project is successful, the pace of putting up turbines would accelerate because the demand for hydrogen would appear every year at planting time, if anything at increasing levels, as farmers sought more fertilizer.

"Whether a subsidy is going to be there or not, you don't care because you've got a customer," Massie says. "That's not a subsidy, that's a business."

The pilot system will produce 365 tons of ammonia a year.

Using locally produced fertilizer will enhance energy security, Massie says.

"If your oil supply lines are vulnerable to being cut, so are your ammonia supply lines," Massie says. "If we convert our economy to run on renewable energy but it was reliant on foreign natural gas, you really haven't bought yourself anything. To the extent that we can move this stuff within our own domain, we become the masters of our own fate." ■

Investing in the future:
Scholarship program puts students on Capitol Hill

The Washington Connection: When U.S. Rep. Collin Peterson, D-Minn., approached Bob Dinneen, executive director of the Renewable Fuels Association (RFA), two years ago to set up an internship program for University of Minnesota students with the House Agriculture Committee, Dinneen jumped at the opportunity. After all, his Washington-based association's main goal is to promote the use of ethanol as a renewable fuel and Minnesota is the epicenter of the ethanol industry.

The Agricultural and Renewable Fuels Policy Congressional Internship Program, now in its second year, is a joint effort of CFANS, Peterson's office, and the Renewable Fuels Association. Upper-level CFANS students who are residents of Minnesota qualify for the internship based on GPA, work experience and interests.

"It's an opportunity for students to gain an appreciation for how Washington works and to learn how their senators and representatives are working to represent their interests," says Dinneen. RFA's role is mostly financial, Dinneen says, but the organization also hosts the interns for a day to learn about their aspirations and to inform them about RFA's lobbying role on Capitol Hill. RFA's annual support of the program is about $15,000 and helps the interns defray living expenses. This spring's intern is Lucas Sjostrom, a sophomore agricultural education major from Lafayette, Minn.

> "It's an opportunity for students to gain an appreciation for how Washington works and to learn how their senators and representatives are working to represent their interest."

"It's rewarding to see young people filled with enthusiasm," Dinneen adds. "And it's refreshing to see the quality of young people the university is putting out these days." When he was younger, Dinneen completed a Capitol Hill internship for a U.S. representative from New Jersey, but he says his experience did not have the substance of the renewable fuels internship. "The committee is making more of an effort to involve interns in policy evaluations, research and assessment of legislation," Dinneen notes. "It's a much more intense and meaningful experience."

Bob Dinneen

Dinneen has headed up RFA for the bulk of the organization's lifespan. "I found out about the job from a buddy who was working with the National Corn Growers Association," Dinneen recalls. "He says he didn't know how long (ethanol and thus RFA) would last, but that at least we would have fun working together. That was 20 years ago." *–Fran Howard*

CFANS student enjoys being in the middle of the action

Lucas Sjostrom *Rep. Collin Peterson*

This semester's recipient of the RFA scholarship is Lucas Sjostrom, a sophomore agricultural education major.

The biggest surprise for him: "The privileges I was given right away," he says. Since starting the internship in January, Sjostrom has been involved in everything from setting up committee hearings and gathering briefing materials to ferrying mail and documents to other parts of the U.S. Capitol. "We were given full staff privileges right away," he says. He and a student from Texas A&M are the only two interns in the Agriculture Committee offices this semester.

"I kind of wondered when I went out there whether they would even let me get close to Rep. Peterson," says the 20-year-old from Lafayette, Minn. "But we're doing pretty meaningful stuff."

Back to the Islands:

CFANS grad's experience sends him to the top of ag agency

Louis Petersen

As soon as he finished work at CFANS on his doctorate in horticultural science, Louis Petersen headed back to his native Virgin Islands.

> "My studies caused me to look at plants in a completely different way."

"I never in my life thought I would have to go somewhere so cold," Petersen says, but his studies led him in 1984 to work being done at the University of Minnesota on drought-tolerant Phaseolus beans.

"I've always been interested in interdisciplinary studies," Petersen says. It was that interest that made him eligible for a fellowship that incorporated horticulture with stress physiology. Petersen's studies focused on hybrid progeny of kidney and tepary beans. "I wanted to study something that would be relevant that I could take back home," he adds.

> "Agriculture was our main industry for a very long time. In the 1960s, our new administration decided to move from agriculture to tourism."

After five years at the University of Minnesota, Petersen returned to

St. Thomas to become a cooperative extension agent for the University of the Virgin Islands. There he helped farmers learn to read plant responses, a technique he learned in Minnesota. "My studies caused me to look at plants in a completely different way," he says.

Petersen worked his way up through the Virgin Islands' cooperative extension service to become an extension district supervisor before being appointed as the Assistant Commissioner of Agriculture in 1995, a four-year term. Upon completing his appointment, he resumed his position as district supervisor until February 2007, when he began his current appointment as Commissioner of Agriculture.

Petersen now works out of two offices, one on St. Croix and one on St. Thomas, the two largest agricultural producing islands. His department monitors a variety of crops, including mangos, papayas, pineapples, coconuts, bananas, plantains, cashews and various berries. "Culinary and medicinal herbs are also big crops for us," he notes. "To drink herbal tea is a very common thing here." And while the islands have a livestock industry, it is rapidly disappearing.

"Agriculture was our main industry for a very long time," Petersen explains. "In the 1960s, our new administration decided to move from agriculture to tourism." While the shift has proved beneficial to the U.S. territory, much of the land that was zoned for agriculture — all of it owned by the government — has been rezoned, eroding the cultivated land base. "One challenge we face is to stop that erosion," Petersen says. Currently, 99.5 percent of the islands' food comes from the U.S. mainland. "We want to significantly reduce that number, but we cannot undo in four years what occurred over 40 years. If we reduce that number by 5 or 10 percent by the end of my term, we would have done a lot."

–Fran Howard

> "One challenge we face is to stop that erosion."

Seeds of greatness:
Ron Phillips' achievements earn international honors

Ron Phillips works with student Toi Tsilo.

University Regents Professor of Agronomy and Plant Genetics Ron Phillips has won the coveted 2007 Wolf Prize in Agriculture. German philanthropist Ricardo Wolf established the annual award for agriculture, chemistry, mathematics, medicine, physics and the arts.

The $100,000 prize will be given at an award ceremony May 13 in Jerusalem. Since the award's inception in 1976, 232 scientists and artists have been honored in six disciplines.

According to the Wolf Foundation, Phillips won for groundbreaking discoveries in genetics and genomics. He was the first to generate whole corn plants from cells grown in culture, laying the foundation for genetically modifying corn plants and other cereals.

> "Farmers across the world have begun to farm with these improved seeds."

"It is much easier to work with millions of corn cells than with millions of corn plants," says Phillips. "We have discovered how to identify unique traits in the cells, to choose specific cells and finally, to grow them into plants. "Farmers across the world have begun to farm with these improved seeds. The latest data show a 13 percent worldwide rise in the use of biotechnology seeds in the past year. Since 1996, 1.4 billion commercial acres of biotech crops have been grown.

"In 1987, the National Academy of Sciences stated that the technology was safe," Phillips says. "Twenty years later, it remains reliable. What we must monitor is the product, but this issue is not unique to genetic engineering. Before a seed can be grown, it must undergo rigorous regulatory processes."

Studies in Phillips' lab also led to the identification of cells and plants with increased levels of essential amino acids and the development of an efficient DNA sequence mapping system used by plant scientists in genomics research.

Phillips received his doctoral degree in genetics from the University of Minnesota, and his research at the U was one of the earliest programs in modern plant biotechnology related to agriculture.

He is world renowned for his leadership and service in international agricultural research communities and for his teaching and training in the plant genetics field. He is a member of the National Academy of Sciences.

> "We have discovered how to identify unique traits in the cells, to choose specific cells and finally, to grow them into plants."

Today, Phillips is focused on genomics research — looking at all the genes as a dynamic system rather than at individual genes. His latest project involves studying the genetic control of oil in a high-oil corn line with 20 percent oil (compared with a normal value of 3.5 percent) to produce bio-renewable energy. Another project is solving the human pathogen problem of E. coli O157:H7, the bacterium involved in contaminating food such as hamburger and spinach. He and a colleague are working to identify a pair of genes that counteract the harmful bacterium and on transferring these genes to corn. *–Kristi Goldade*

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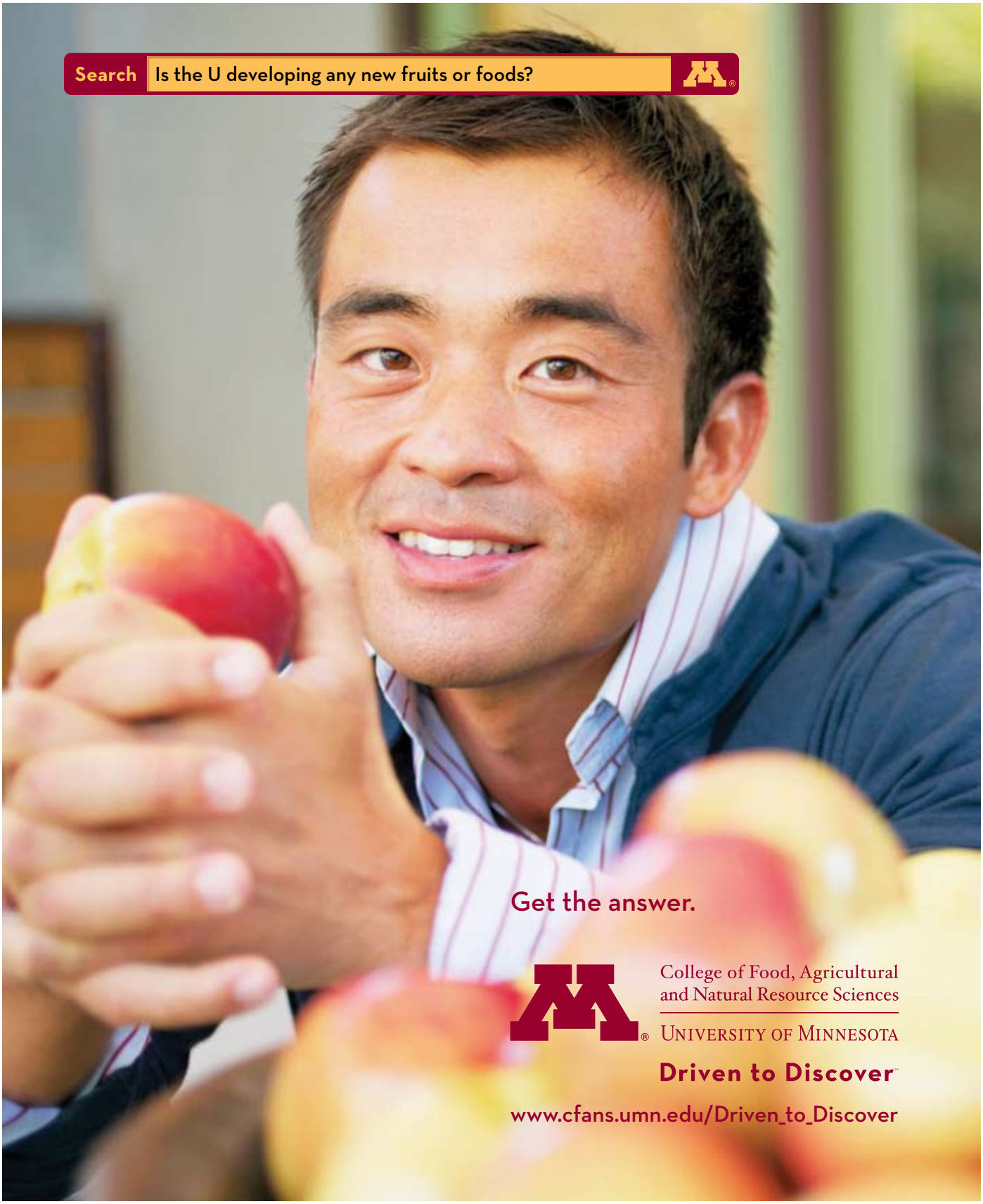
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CFANS 2007 CALENDAR OF SUMMER EVENTS

These are some of the many events supported by the College of Food, Agricultural and Natural Resource Sciences. All are open to the public; some may require a registration or fee to attend. Visit www.cfans.umn.edu/Events2.html or contact Honey VanderVenter at 612-625-6710 or hvander@umn.edu for more information.

May 31
H.K. Hayes Memorial Lecture, featuring Fazle Hasan Abed, founder and chair of BRAC (formerly the Bangladesh Rural Advancement Committee). Sponsored by the Department of Agronomy and Plant Genetics.

June 7–9
Gopher Dairy Camp, St. Paul campus.

June 19
Agronomy Field Tour, Southern Research and Outreach Center, Waseca, Minn.

June 21
St. Paul Campus Reunion for alumni from the Colleges of Food, Agricultural and Natural Resource Sciences; Design; Biological Sciences; Education and Human Development; Veterinary Medicine and the School of Agriculture.

June 16–September 3
Art to A-Maze exhibition, Minnesota Landscape Arboretum, Chaska, Minn.

July 9
Golf Scramble for Scholarships and Silent Auction, sponsored by the CFANS Alumni Association, at the University of Minnesota Les Bolstad golf course.

July 11–12
Field Days, Southwest Research and Outreach Center, Lamberton, Minn.

July 19
Agriculture Open House, St. Paul campus, sponsored by CFANS, University of Minnesota Extension and the Minnesota Agricultural Experiment Station.

July 26
Horticulture Night, West Central Research and Outreach Center, Morris, Minn.

August 7–9
Farmfest, near Redwood Falls, Minn.
University on the Prairie, Southwest Research and Outreach Center, Lamberton, Minn.

August 16
Open House – UMore Park, Rosemount, Minn.

August 23–September 3
Minnesota State Fair, St. Paul, Minn.

September 4
Fall semester classes begin

September 8
Alumni and Friends Day at the Cloquet Forestry Center in Cloquet, Minn.

September 13
Open House – Southern Research and Outreach Center, Waseca, Minn.

September 18–21
Department of Plant Pathology Centennial, St. Paul campus.

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